10:39:04 OCA PAD INITIATION - PROJECT HEADER INFORMATION 09/22/95

Active

Project #: E-24-549 Cost share #: Rev #: 0
Center # : 10/11-6-P5484-0A0 Center shr #: OCA file #:
Work type : INST
Contract#: DMI-9527476 Mod #: Document : GRANT
Prime #: Contract entity: GTRC

Subprojects ? : N CFDA: NA
Main project #: PE #: NA

Project unit: ISYE Unit code: 02.010.124
Project director(s):
MCGINNIS L F ISYE (404)894-2363

Sponsor/division names: NATL SCIENCE FOUNDATION / GENERAL
Sponsor/division codes: 107 / 000

Award period: 951001 to 960930 (performance) 961231 (reports)

Sponsor amount	New this change	Total to date
Contract value	15,000.00	15,000.00
Funded	15,000.00	15,000.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: MATERIAL HANDLING RESEARCH COLLOQUIUM IV, THE NETHERLANDS, JUNE 16-19, 1996.

PROJECT ADMINISTRATION DATA

OCA contact: Jacquelyn L. Bendall 894-4820

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NATIONAL SCIENCE FOUNDATION
4201 WILSON BLVD.,
ARLINGTON, VA 22230

Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : NA NA supplemental sheet
Equipment title vests with: Sponsor GIT X
NONR PROPOSED OR ANTICIPATED.
Administrative comments -
INITIATION OF 12-MOS NSF GRANT.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 01/29/97

Project No. E-24-549_____ Center No. 10/11-6-P5484-0A0_

Project Director MCGINNIS L F_____ School/Lab ISYE_____

Sponsor NATL SCIENCE FOUNDATION/GENERAL_____

Contract/Grant No. DMI-9527476_____ Contract Entity GTRC

Prime Contract No. _____

Title MATERIAL HANDLING RESEARCH COLLOQUIUM IV, THE NETHERLANDS, JUNE 16-19, 19

Effective Completion Date 960930 (Performance) 961231 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	N	_____
Final Report of Inventions and/or Subcontracts	N	_____
Government Property Inventory & Related Certificate	N	_____
Classified Material Certificate	N	_____
Release and Assignment	N	_____
Other _____	N	_____

Comments_____
LETTER OF CREDIT APPLIES. 98A SATISFIES PATENT REPORT._____

Subproject Under Main Project No. _____

Continues Project No. _____

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other _____	N
_____	N

E-24-549
#1

OMB Number 3145-0058

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PI/PD Name and Address

Dr. Leon F. McGinnis
School of Industrial and Systems Engineerin
Georgia Institute of Technology
Atlanta, GA 30332-0205

NATIONAL SCIENCE FOUNDATION
FINAL PROJECT REPORT

PART I - PROJECT IDENTIFICATION INFORMATION

1. Program Official/Org.	Pius Egbelu
2. Program Name	Div. Design and Manufacturing
3. Award Dates (MM/YY)	**From:** Oct. 1, 1995 **To:** Sept. 30, 1996
4. Institution and Address	Georgia Tech Research Corporation Georgia Institute of Technology Atlanta, GA 30332
5. Award Number	DMI-9527476
6. Project Title	"Material Handling Research Colloquium IV, The Netherlands, June 16-19, 1996"

This Packet Contains
NSF Form 98A
And 1 Return Envelope

NSF Grant Conditions (Article 17, GC-1, and Article 9, FDP-11) require submission of a Final Project Report (NSF Form 98A) to the NSF program officer no later than 90 days after the expiration of the award. Final Project Reports for expired awards must be received before new awards can be made (NSF Grants Policy Manual Section 677).

Below, or on a separate page attached to this form, provide a summary of the completed projects and technical information. Be sure to include your name and award number on each separate page. See below for more instructions.

PART II - SUMMARY OF COMPLETED PROJECT (for public use)

The summary (about 200 words) must be self-contained and intelligible to a scientifically literate reader. Without restating the project title, it should begin with a topic sentence stating the project's major thesis. The summary should include, if pertinent to the project being described, the following items:

- The primary objectives and scope of the project
- The techniques or approaches used only to the degree necessary for comprehension
- The findings and implications stated as concisely and informatively as possible

PART III - TECHNICAL INFORMATION (for program management use)

List references to publications resulting from this award and briefly describe primary data, samples, physical collections, inventions, software, etc. created or gathered in the course of the research and, if appropriate, how they are being made available to the research community. Provide the NSF Invention Disclosure number for any invention.

	2/15/97
Principal Investigator/Project Director Signature	Date

I certify to the best of my knowledge (1) the statements herein (excluding scientific hypotheses and scientific opinion) are true and complete, and (2) the text and graphics in this report as well as any accompanying publications or other documents, unless otherwise indicated, are the original work of the signatories or of individuals working under their supervision. I understand that willfully making a false statement or concealing a material fact in this report or any other communication submitted to NSF is a criminal offense (U.S. Code, Title 18, Section 1001).

IMPORTANT:
MAILING INSTRUCTIONS
Return this *entire* packet plus all attachments in the envelope attached to the back of this form. Please copy the information from Part I, Block I to the *Attention* block on the envelope.

PART II - SUMMARY OF COMPLETED PROJECT

The Material Handling Research Colloquium (MHRC) has been held four times in the past eight years. Each Colloquium has been jointly sponsored by the National Science Foundation, the Material Handling Education Foundation, and a variety of companies in the material handling Each Colloquium has resulted in the publication of a proceedings; MHRC IV Proceedings will be published by The Material Handling Industries of America in early 1997.

MHRC IV was held in Vught, The Netherlands--the first international site for the Colloquium. Thirty-five academic researchers and twenty-seven participants from industry met to learn about and discuss the current state of research in material handling, and to attempt to identify important directions for future research. This report presents a synopsis of the Colloquium; the full Colloquium Proceedings will contain papers from the participants as well as reports on the breakout discussion groups.

PART III - TECHNICAL INFORMATION

FINAL REPORT
DMI-9527476

"Material Handling Research Colloquium IV,
The Netherlands, June 16-19, 1996

Submitted by:

Leon F. McGinnis
Georgia Institute of Technology
Atlanta, GA 30332-0406

January 15, 1997

Summary

The Material Handling Research Colloquium has been held four times in the past eight years. Each Colloquium has been jointly sponsored by the National Science Foundation, the Material Handling Education Foundation, and a variety of companies in the material handling Each Colloquium has resulted in the publication of a proceedings; MHRC IV Proceedings will be published by The Material Handling Industries of America in early 1997.

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1. BACKGROUND

The 1996 International Colloquium on Material Handling Research was held at Motel Vught, Vught, The Netherlands on June 16 - 19. This was the fourth biennial colloquium, and the sixty-two participants at the 1996 event constituted a record number of attendees. It is interesting to compare the mix of institutional affiliations of attendees of the most recent versus two previous colloquia, as shown Table I below.

TABLE I. Colloquium Attendance Comparisons

Institutional Affiliation	1996 CMHR IV	1994 CMHR III	1992 CMHR II
Academe	35	28	25
Industry/ Consulting	27	14	15
Total	62	42	40

We see from Table I that not only has there been an increase in participation in the colloquium over the most recent three events, but the increase has been from both the academic (40% increase) and the industry/consultant (80% increase) sectors.

Although an international event, 1996 is the first time that the colloquium has been held outside the United States. As a result, there was much greater participation by researchers and industry representatives from Europe than in the past. Of the sixty-two participants, thirty-one represented universities, industries or consulting firms from the U. S. or Canada, and thirty-one represented universities and industries (including U.S. industries with European offices) from Europe.

The objectives of the colloquium were to share research results and current thinking regarding material handling research; to strengthen the material handling research infrastructure by providing a venue for networking among researchers and material handling industries; and, to attempt to determine a direction for future research in material handling.

The agenda for the colloquium consisted of presentation sessions and focus group discussions. As has been the case in previous colloquia, the topics of the presentation sessions were developed by an organizing committee (including the editors of this volume) through a process of categorizing the papers submitted by the participants. The presentation topics for 1996 included:

- Concepts for design and layout

- Material handling system evaluation methods
- Modeling and analysis of controlled mechanical storage systems
- Technology development and deployment
- Future needs / industry perspectives.

Speakers presented overviews of their work, perspectives on the topical area, and shared their thoughts on future directions and research needs. Since all attendees had been furnished a preprint copy of the proceedings well in advance of the colloquium, a brief discussion and question session followed each presentation. Attendees were also encouraged to continue discussions with presenters at session breaks and meal functions.

Each attendee was given the opportunity to participate in one of six focus groups. Anyone who did not select a group in advance of the event was assigned one by the organizers so that the membership sizes of all groups were approximately equal. The charge to each focus group was to identify and assess the current status, future directions, critical issues, and barriers to implementation in some specific area of material handling research. Focus group topical areas were:

- Infrastructure/networking in material handling R&D
- Object oriented modeling and analysis
- Breakthroughs in practice
- Economic justification of automated material handling systems
- Agile manufacturing
- The age of customization for retail consumer goods.

The focus groups met at scheduled times during the colloquium, exchanged ideas, and discussed their topics. Each focus group prepared a report which was delivered on the final day of the colloquium. The group reports are also included in this volume.

Taking advantage of the European location, a post-colloquium tour of several industries was offered to North American attendees at reduced cost. The tours included the following facilities:

Facility	***Location***
European Container Terminal	Maasvlakte (Rotterdam), The Netherlands
Nike European Distribution Centre	Laakdal, Belgium
TPC Parcel Handling Facility	Krehfeld, Germany
Fraunhofer Institut	Dortmund, Germany
Phoenix Pharmaceutical Distribution Centre	Bornig, Germany
Opel Assembly Plant	Bochum, Germany

2. PERSPECTIVES ON CHANGE IN MATERIAL HANDLING RESEARCH

It is not easy to develop a coherent perspective on material handling research from a diverse collection of papers in a proceedings. Nevertheless, since the second colloquium in 1992, the editors have attempted to provide two sets of statistics which may be useful in gauging change. They first assume that material handling systems can be viewed as consisting of the four key elements:

- Hardware: Equipment, control hardware, containers, etc.
- Controls: Motion control, tracking, location assignment, operation sequencing, etc.
- Strategies: Zoning in an AS/RS, dispatching in an AGVS, etc., and
- Interfaces: Physical and logical interfaces to the external environment.

Further, the creation of material handling systems requires four phases of activity: Specification, design, installation, and operation. Thus, using these elements as rows and the phases of activity as columns, a matrix form of material handling systems research domains has been used to categorize the research papers submitted to the colloquia in 1992 and 1994. This matrix is updated in Figure 1 with the editors' categorization of the 1996 colloquium papers. Note that in Figure 1, an element for "systems" has been added, and that hardware and controls for operation have been combined.

The three-tuple constituting the elements of the matrix in Figure 1 give the number of papers in each category submitted in 1996, then in brackets, the same number for papers submitted in {1994, 1992}.

Phases of Activity / Elements	Specify	Design	Install	Operate
Hardware		7,{1,1}		
Controls		4,{1,6}		2,{0,2}
Strategies		1,{0,0}		0,{2,0}
Interfaces		1,{2,0}		0,{0,0}
Systems	4,{3,5}	14,{11,9}		4,{7,5}

Figure 1. Matrix Form of Research Paper Classifications for 1996, {1994, 1992}

Most of the statistics shown in Figure 1 are consistent across the three colloquia with the notable exception of the element for hardware design. This may have been the result of a greater participation of mechanical engineering faculty as well as research faculty from Europe in the 1996 colloquium.

The other notable trend in the matrix elements of Figure 1 is the continued increase (55% over the last three events) in the number of papers concerned with the design of material handling systems.

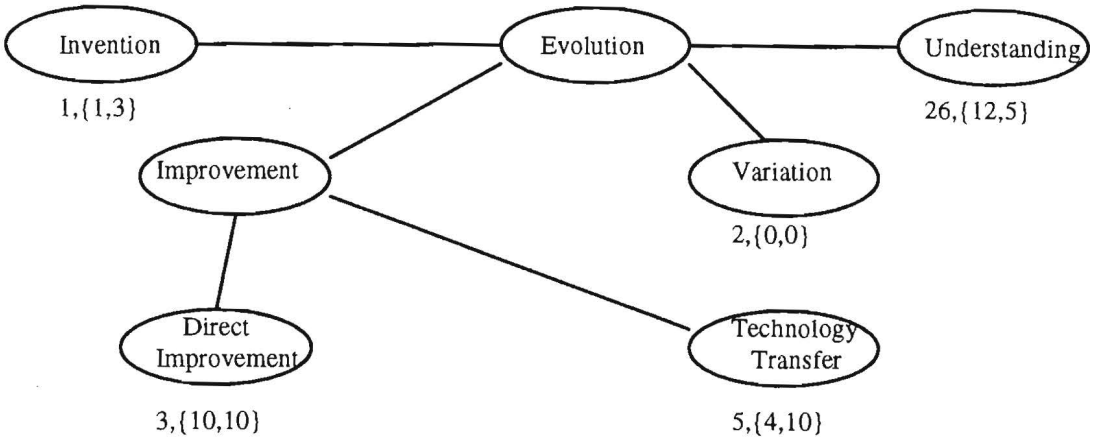

Figure 2. 1996, {1994, 1992} Colloquium Paper Classification by Phases of Development

As seen in the classification of Figure 2, an alternate means for classifying the research papers submitted to the 1996 colloquium is continued from the previous ones. This scheme accounts for the normal development of materials handling systems from *invention* through *evolution* to *understanding*.

Of the 37 papers submitted, 8 (or 21.6%) of the papers addressed the "improvement" of an existing design or process compared with roughly 75% for this same category in both 1992 and 1994. Only one paper was classified as "invention", which is in keeping with the number of papers in this category offered at previous colloquia.

The big increase at the 1996 colloquium was the emphasis on "understanding." Approximately 70% of the papers were placed into this category and continues the trend from the previous colloquia of more papers focusing on developing a better understanding of the design and efficient operation of material handling systems.

3. OBSERVATIONS AND FUTURE DIRECTIONS

With the increased industry representation at the colloquium, and the European representatives from organizations such as the Fraunhofer Institut, an interesting observation was made by the editors. That is, the material handling manufacturing industry and vendors are concerned with supplying the needs of the users of material handling equipment and systems. They are concerned with identifying opportunities, analyzing the handling requirements, developing alternatives, performing detailed design and simulations, economically justifying solutions, implementing solutions, and training users.

The majority of the papers in the colloquium, as evidenced by the categorizations in Figures 1 and 2, illustrate that the research community is also concerned with solving the problems of material handling system users. The papers are concerned with system and hardware design, the development of analysis tools, operational (control) and simulation modeling. Additionally, the universities provide degree programs, continuing education and training for the benefit of material handling system users.

However, the intersection of the efforts of these two groups, i.e., material handling companies and the material handling research community (at least at most U. S. universities), is very narrow, primarily the areas of simulation modeling, economic justification and, to some extent, training. This is illustrated in Figure 3. This figure illustrates that many of the analytical models, tools, and operational improvements are developed in the research community with little input or knowledge from the material handling manufacturers, vendors or users.

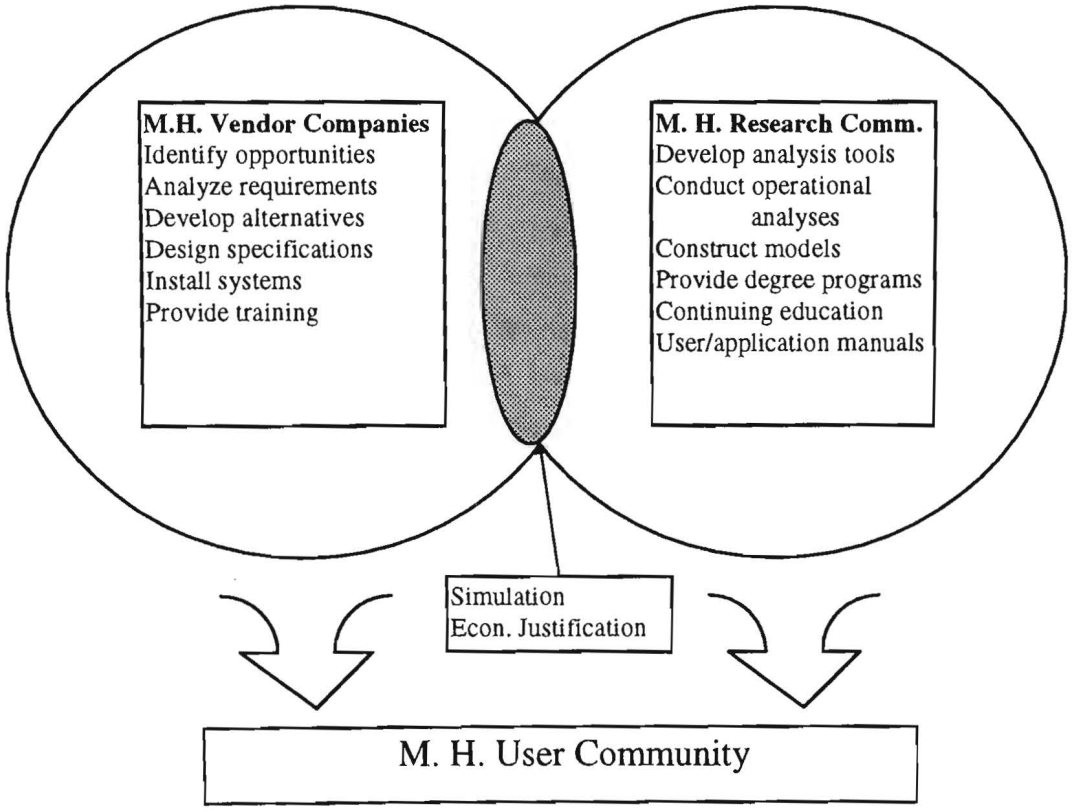

Figure 3. Current interaction between the material handling vendor and research communities in satisfying the needs of the user community

It seemed to be the consensus among both the research community as well as the material handling vendor community representatives in attendance at the colloquium that a better model for the interactions among the three communities shown in Figure 3 might be that shown in Figure 4. In this model, all three communities share problems (or opportunities, needs, etc.), then work together, within the bounds of their respective distinctive competencies, to analyze, apply, design or develop hardware, software and systems necessary to solve specific material handling problems of users. The solutions to specific user problems can then perhaps be generalized to form a market niche for vendor companies, and the general solution approach incorporated into curricula, colloquia, continuing education, and training efforts by the research community.

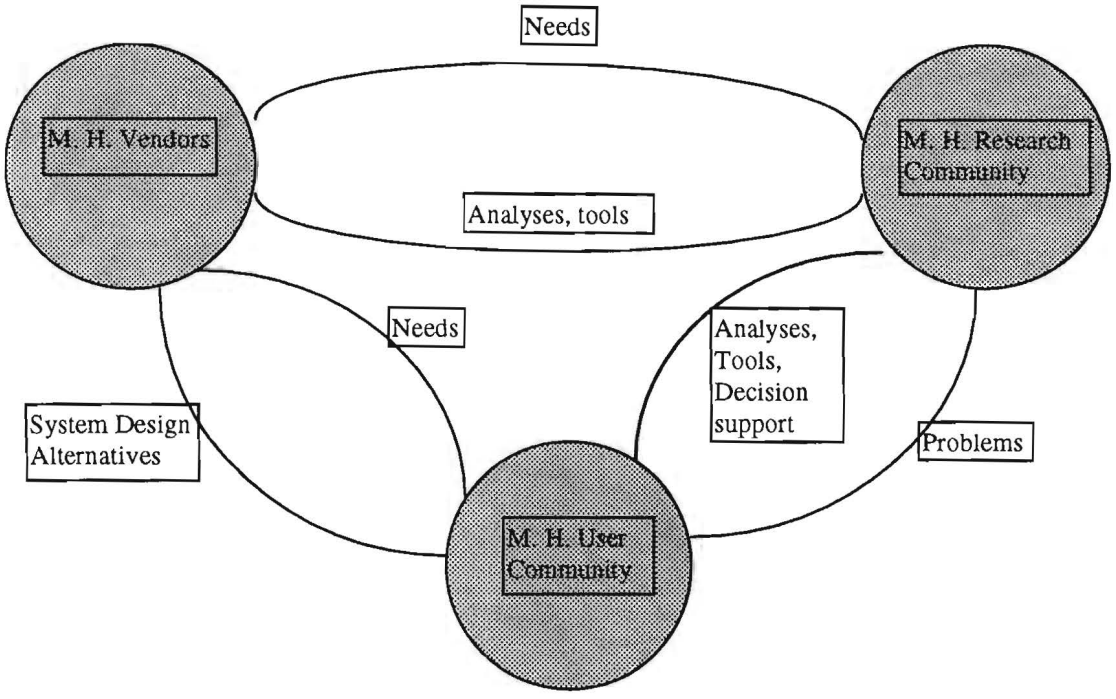

Figure 4. A better model for interaction between the material handling vendor, material handling user, and material handling research communities in satisfying the needs of the user community

The realization of this organized, closer working relationship among the three communities will take a focused, considerable effort. It will require communication among the parties, certainly aided by the continued efforts of the participants in the Material Handling Research Colloquium. If successful, however, the efforts expended will pay substantial dividends in increased commercial and industrial productivity, increased business opportunities for material handling manufacturers and vendors, and the creation, application, and dissemination of new knowledge by material handling researchers.

4. CONCLUSIONS

Material handling continues to be a major contributor to lead time and cost in the value chain linking raw materials to satisfied customers. As in the past, this Colloquium reflects the recognition, by both academic researchers and industry, that collaboration is absolutely essential if research is to benefit industry. A significant outcome of the Colloquium is the identification of a strategy which specifically identifies three constituencies--technology suppliers, technology users, and the research community.